United States Department of Agriculture | Forest Service | Southwestern Region Forest Health Arizona Zone Office | 2500 S. Pine Knoll Drive Flagstaff, AZ 86001-6381 FAX (928) 556-2130 Voice (928) 556-2073

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Subject: Bark beetle activity in Clifton RD WUI projects (cliftonrd)

To: District Ranger, Clifton Ranger District

On August 24, 2004, I traveled to Clifton to meet with Kim Kuhar, District FMO, to assess bark beetle activity in the Blackjack WUI project area on the Clifton Ranger District, Apache-Sitgreaves National Forest. Kim, Clifton RD fire staff, and I visited the Blackjack WUI site and Blackjack Campground to review project treatments, stand conditions, and bark beetle activity. I describe in this report bark beetle activity on the Apache-Sitgreaves, summarize basic bark beetle biology, bark beetle activity within the project area, and make recommendations to minimize bark beetle impacts associated within this and similar fuel and stand density reduction project areas.

Bark beetle activity and biology on the Apache-Sitgreaves NF

Aerial detection surveys conducted by our Forest Health Protection zone office in 2002 and 2003 found high levels of bark beetle-killed ponderosa pine on the Apache-Sitgreaves NF, with more than 200,000 ponderosa pine killed across 100,000 acres in each year. In addition, high levels of piñon pine mortality caused by piñon ips attacking droughts stressed trees was recorded over large areas of the Forest. A detailed summary of the aerial detection survey results for 2004 will be provided to the Forest at a later date; however, preliminary findings include ponderosa pine mortality on approximately 12,000 acres, totaling 25,000 trees killed by Mid-August of 2004. This trend of decreased bark beetle activity on the Apache-Sitgreaves NF is similar to what has been observed in the majority of Arizona during 2004. Nonetheless, there are still areas that are experiencing considerable pine mortality and the population of bark beetles is still relatively high. The vast majority of this pine mortality is related to the ongoing drought that the Southwest Region has been experiencing since 1996.

Inspection of fading ponderosa pine trees and collected specimens determined that engraver beetles (*Ips* species) and western pine beetle (*Dendroctonus brevicomis*) are the primary cause of ponderosa pine mortality on the Clifton RD. These bark beetles are widespread throughout the West and can occasionally reach outbreak proportions (Kegley, et al., 1997, DeMars and Roettgering, 1982, Parker, 1991). Most of the attacked trees show the characteristic fading from the top down associated with *Ips* attacks. Most of the larger diameter pine with top kill also have western pine beetle in the lower portion of the trunks. Red turpentine beetle (*D. valens*) is present at the base most infested trees.

Pine engraver beetles. Adult pine engraver beetles attack smaller diameter trees and tops of larger trees, but their preferred host material is fresh pine debris from construction, logging, firewood cutting, or wind and snowstorms. Living trees can be attacked and killed once populations have built up in fresh pine debris. Two to three generations are produced per year.

Adults emerge from overwintering material and fly to find new hosts in the spring (i.e., early April). Pine engraver beetles flights continue into the fall as long as daytime temperatures remain above 60° to 65° F. Generation time from egg to mature adult beetle ranges from one month to 8 weeks, with the shortest development time in mid-summer. Males initiate attacks and release chemicals, which attract females. Adults build galleries (or tunnels), mate, and lay eggs. Galleries are distinctive. Typically there is a central nuptial chamber (an enlarged area) from which several more or less linear adult galleries radiate. Galleries slightly etch the sapwood, hence the common name, engraver beetle. Three or more egg galleries originate from the nuptial chamber in the shape of a tuning fork. Adult galleries are open and not packed with boring dust in contrast to *Dendroctonus* beetles. Larvae (immature beetles) feed in their own galleries perpendicular to the adult galleries for a few weeks before pupating. Pupae turn into adults to complete the cycle. Evidence of attack includes fading foliage, red boring dust in bark crevices and occasionally small pitch tubes on trunks of live trees. Because attacks are typically initiated near the tops of trees, the crown fades from the top down.

Western pine beetle. The western pine beetle attacks trees of all sizes larger than 6 inches in diameter. However, large, old trees are attacked most commonly. Unlike the pine engraver beetles, this insect attacks living trees and rarely is found on pine debris. Best evidence of attack is the presence of pitch tubes (up to 1 inch in diameter) in the bark, often in bark crevices. Under the bark, galleries are mazelike and do not etch the wood (contrast with pine engraver beetles). Life cycle is quite similar to engraver beetles. All life stages are found in bark. Between two and four generations are produced per year. Flight and attacks start in late spring or early summer and continue until the onset of cold weather in fall. Attacks are initiated by adult females, usually at mid to lower trunk. The infestation process is mediated by chemical messengers or pheromones released by the beetles in combination with host tree chemicals. Adults construct egg galleries. They differ from pine engraver beetles galleries in their shape and by the fact that they are packed with boring dust. Larvae feed in their own galleries perpendicular to the adult galleries. Later larval stages tunnel in the middle bark before pupating and eventually emerging. One generation requires between 2 and 10 months depending on temperature.

Bark beetle activity in the Blackjack Campground

The Clifton RD conducted a thinning/restoration project within the Blackjack CG in the fall of 2003. Thinning treatments were completed by the end of December 2003 and then slash was burned in March of 2004. The resulting post-treatment conditions have adequate intertree spacing and a nice mix of ponderosa pine, oak and juniper. I conducted a walkthrough survey of the Blackjack CG to detect past and current levels of bark beetle activity. Based on fading patterns of attacked trees and other signs, I observed that the majority of dead trees had been attacked prior to implementation of thinning operations (i.e., beetles were already present at the site and not necessarily drawn into the site). A total of seven ponderosa pine were found in the campground that had current bark beetle attacks. Five of these were large diameter yellow pine that had been attacked by a combination of *Ips* beetles in the top portion of the bole and western pine beetle in the lower bole (***Figure 1***). The other two ponderosa pine were small diameter trees (<4 inches DBH) and had apparently been attacked by twig beetles and woodborers. In addition, six large diameter yellow pines had been attacked by bark beetles in 2003 within the campground and several pockets of large diameter pines had been attacked in previous years in areas adjacent to the campground.

Bark beetle activity in the Blackjack WUI project area

The Blackjack WUI project is being completed under Healthy Forest Restoration Act (HFRA) authorities. The project area encompasses 2,200 acres across diverse vegetation types; ranging from ponderosa pine to woodland to brush. The primary objective of the project was to reduce hazardous fuels conditions in and around private land and the Blackjack CG. Other objectives included habitat improvement and the reintroduction of fire to establish a historical fire regime. Desired future conditions include an 80% reduction of the piñon-juniper with a minimum of 75 trees per acre; and improving ponderosa pine stands to an open mature stand generally with less than 40% canopy with mixed age classes.

The initial phase of this project included thinning on 125 acres around private land and the campground in December 2003. Prescriptions for the thinning treatments included:

1. Thin juniper species 10 inches or less in diameter.
2. Thin all pine species 8 inches or less in diameter.
3. Do not thin ponderosa pine less than 2 feet in height.
4. Thin all oak species less than 6 inches in diameter with a spacing of 8 to 12 feet.
5. Do not cut oak less than 1 foot in height.

Slash was piled in the campground and directly adjacent to private land and was burned in March of 2004. Slash was lop and scattered in the remaining areas of the thinning units and provided the public with fuelwood opportunities (***Figure 1***). Slash that was not collected as fuelwood was burned in the spring of 2004.

Based on a walkthrough survey of this restoration project, I observed piñon and juniper mortality to be occurring at levels less than one tree per acre which indicates endemic conditions. Similarly, very low levels of ponderosa pine mortality were observed within the project boundaries.

Proposed Clifton Ranger District Restoration Projects

The Clifton RD has requested Prevention/Suppression/Restoration funds from Forest Health Protection to conduct three forest health restoration projects. 1. Granville CG area (50 acres), 2. Pine Flats/Mallett area (200 acres), and 3. Stray Horse Work Center (200 acres). The areas within the project are severely degraded in terms of tree density and bark beetle impacts. Tree densities currently exceed 600 to 1,000 trees per acre with an understory of piñon pine, juniper, and oak and other species that contribute to water stress for forest species and extreme fuel loadings that can result in unmanageable wildfire conditions. High levels of ponderosa pine, piñon, juniper, and Arizona cypress mortality have been detected on the District during 2002 and 2003 resulting in large volumes of standing and down fuels. Objectives of these projects include reducing tree density related stress on residual trees, removing live and dead fuels, and increasing the defensibility of developed sites and adjacent private lands in the event of a catastrophic wildfire. Treatments would include preventative and restoration thinning prescriptions followed by prescribed fire. Treatments would focus on removing understory trees in ponderosa pine stands and creating openings in the piñon/juniper fuel type to reduce overall trees per acre.

Concurrently, a grant has been proposed to treat private lands adjacent to the Pine Flats/Mallet project area through a partnership between Greenlee County, Clifton Ranger District, and the residents in the Pine Flats area and along Eagle Creek.

Figure 1. *Old and current ponderosa pine mortality within the Blackjack CG, Clifton Ranger District (top left); western pine beetle galleries on ponderosa pine in the Blackjack CG; this tree had also been attacked by Ips in the top of the tree (top right); pre-treatment stand conditions in the Blackjack WUI fuels reduction project, Clifton Ranger District (bottom left); post-treatment stand conditions in the Blackjack WUI fuels reduction project.*

Silvicultural treatments for reducing bark beetle susceptibility

I provide here general preventive measures for future fuel reduction/thinning projects and then provide more specific recommendations for the Blackjack project area. Most of this information is included in the Integrated Pest Management Guide for *Ips* species attacking ponderosa pine (Parker 1991). This publication is available online at http://www.fs.fed.us/r3/publications/documents/ipm_guide.pdf

Management of bark beetle populations falls under two categories: direct action against the beetles themselves (suppression) or indirect action that addresses the general stand conditions (prevention). Direct action deals with the symptoms, too many beetles in one place at one time, and is aimed at directly reducing the number of beetles present. Indirect action focuses on the cause of the problem, which relates to optimal stand conditions for beetle buildup and outbreak. The only effective long-range strategy to minimize beetle-caused mortality is controlling stand conditions through silvicultural means over large areas and constant monitoring for areas of beetle buildup.

Silvicultural treatments are designed to increase tree vigor and reduce stand susceptibility to beetle attack through reducing basal area or controlling other stand conditions. They are preventive treatments that should be completed prior to stands experiencing beetle outbreaks. Stand hazard rating for *Dendroctonus* bark beetles of ponderosa pine involves measures of tree size, stand or group density (basal area), and the percent of host trees within the stand. No stand hazard rating models have been validated for pine engraver beetles species attacking ponderosa pine in Arizona, primarily because beetle populations are often driven by drought and factors leading to large amounts of slash. Stand hazard rating for *Dendroctonus* bark beetles attacking ponderosa pine typically involves measures of tree size, density (basal area or stand density index), and the percent of host trees within the stand. In general, ponderosa pine stands that have an average DBH greater than 12 inches and a basal greater than 120 ft^2/acre are considered at high risk to bark beetle attack, stand basal area of 80 – 120 ft^2/acre are moderate risk, and stand basal area less than 80 ft^2/acre are considered low risk (Schmid and Mata, 1992; Chojnacky et al., 2000; Negrón et al., 2000).

Although no stand hazard rating system has been developed for bark beetles attacking ponderosa pine on the Payson RD specifically, Munson and Anhold (1995) developed the following stand hazard rating system for mountain pine beetle in ponderosa pine (table below modified from Chojnacky et al., 2000). This hazard rating system was validated across several sites including the North Kaibab in Arizona.

% PP		Ave. PP DBH		Basal Area (ft^2/ac)		Composite Stand Hazard Values	Hazard Rating
>85	(3)	>12	(3)	>120	(3)	8 – 9	High
50-85	(2)	8-12	(2)	80-120	(2)	5 – 7	Moderate
<50	(1)	<8	(1)	<80	(1)	3 – 4	Low

For prevention of western pine beetle attacks in California, thinning of dense, 70 to 80 year-old sawtimber stands is an effective silvicultural method for managers of both small and large holdings (DeMars and Roettgering, 1982). Demars and Roettgering (1982) state that by reducing stand stocking to 55 to 70 percent of the basal area needed for full site utilization will relieve the competitive stress among the residual trees, improve their vigor, and make them less prone to successful bark beetle attack.

Because of the more xeric conditions in the Arizona compared to other western states that have ponderosa pine, the low risk category may be even less than 80 ft^2/acre. Also, because of the large complex of pine engraver beetles that typically cause the majority of ponderosa pine in the

Arizona, average stand diameter may not be as important as other areas in the West where *Dendroctonus* beetles cause most of the tree mortality.

Careful management of the thinning slash is recommended while bark beetle populations are high. Thinning will usually be most effective in areas that are not currently experiencing high levels of beetle activity. In general, population increases of pine engraver beetle can be minimized by implementing thinning projects after the onset of the monsoon season through December. Cutting trees during this season will allow the material to partially dry out before beetles fly in the spring. Also standing residual trees may be less susceptible during this time due to increased soil moisture caused by the monsoon rains. Slash generated from January through May typically remains moist and enhances beetle population increases. While this is a good general recommendation when beetle populations are relatively low, we have observed pine engraver beetles to complete at least one generation in slash generated during the fall of 2002 and 2003 on most Forests in Arizona. If this timing approach is being used, and trees are only lopped and left on untreated on the site, there are a couple points to consider. First, slash generated on more exposed areas that have relatively low residual basal area will likely dry out more by the time beetles fly in the spring. Second, on steeper slopes or where the residual basal area is still relatively high, slash may not adequately dry out by the time beetles fly in the spring.

Another general "rule of thumb" approach to preventing pine engraver beetles from impacting areas where thinning projects are being implemented is to separate project areas either in time and/or in space. Beetle populations probably will remain relatively low if thinning projects are conducted every other year. Similarly, a buffer of over two miles between management sites is also thought to prevent mass movement of beetles from one area to another. If thinning treatments are implemented in consecutive years, there likely will be a build up of pine engraver beetles that can move from one thinning project to the next.

The best preventive strategy to minimize pine engraver beetle activity related with thinning projects and associated slash is to utilize or treat the larger diameter slash. Harvesting or treating most ponderosa pine slash larger than 4 inches in diameter will help to prevent beetle populations increases because few beetles are produced in slash less than 4 inches because this material dries out quicker and there can be more competition for less food. The larger diameter slash should be removed from the site or treated within 28 days of being generated if thinning occurs during active beetle flight periods (April through early October). If thinning occurs during November through March, the larger diameter material should be removed or treated before the time beetles complete their first generation in the spring (i.e., by early May). If slash does become infested in April, removing or treating the newly infested material may aid in reducing the local population of pine engraver beetles.

Recommendations

Blackjack CG

I recommend residual trees that are currently infested with beetles be cut and removed from the site or treated on site as soon as possible. Bark beetle brood will likely complete their development within the next few weeks and then seek overwintering sites. Therefore, treating these infested trees will help to reduce the local beetle population. Obviously, once the beetles have emerged from these trees, cutting them will not reduce beetle populations. Examples of onsite treatments include: cut and burn on site, cut and bury at least 6 inches deep on site, cut and

chip, or cut and debark. When burning infested trees or slash, the material does not need to be entirely consumed; only the outer bark and cambium needs to be charred significantly enough to kill the developing brood.

Proposed Restoration/Forest Health Projects

Based on the District priorities, project NEPA status, projects costs, etc., I recommend that the Clifton RD work to complete the 200 acre restoration project in the Pine Flat/Mallet area during FY2005. Restoration funds have also been requested by Greenlee County Cooperative Extension to complete thinning/fuel reduction treatments on private lands adjacent to the District's proposed project. The combination of projects on both Federal and private lands will greatly reduce hazardous fire risk and bark beetle susceptibility to forested areas at this site.

It will be important to keep an eye on the residual trees after treatments have been completed. If residual trees are observed to begin fading, prompt cutting and treatment of these trees will help to reduce the build up of pine engraver and other bark beetle populations. However, using the slash management guidelines outlined above is a better preventative strategy.

Restoration funds have been requested for two additional project areas (Granville CG and Stray Horse Work Center) on the Clifton RD. I recommend the District work to complete these projects in late FY2005 or early FY2006. At that time, NEPA documentation will have been completed and the projects will be ready to proceed. Keep in mind that additional funds outside of the normal Prevention/Suppression/Restoration program may become available later in FY2005 to assist in the completion of these projects.

If you have any questions regarding my assessment of forest conditions and bark beetle activity within the project areas, potential effects on residual standing trees, or my recommendations, please let me know. I can be reached at (928) 556-2074.

/s/ Joel D. Mcmillin
JOEL D. McMILLIN
Entomologist, Forest Health,
Arizona Zone

cc: Kim Kuhar, Deb Bumpus, John Anhold, Debra Allen-Reid, Leonard Lucero, Frank Hayes, Mailroom R3 Apache Sitgreaves

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